Conference Report

2nd French plenary meeting on Gold Nanoparticles in physics, chemistry and biology, on December 3 and 4, 2007 in Lyon www.or-nano.org

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This second French plenary meeting on Gold nanoparticles took place in Lyon, on December 3 and 4, 2007 (see *Gold Bull.* ***40/1*** (2007) 86). This new event gathered about 80 French researchers, post docs and PhD students. Let us remind that this type of meeting is organised within the framework of the CNRS[1] "group of research" Or-Nano (Gold-Nano), the goal of which being the establishment of scientific relationship between scientists working on gold nanoparticles in different fields: chemistry, physics and biology.

The goal of this new meeting was to establish the state of the art of the latest results obtained in France on gold nanoparticles in these different fields and also to provide new information through four plenary lectures in field not yet discussed in the former meeting: plasmonic, nanothermic, electrochemistry, as well as toxicology. In addition, a total of 19 oral communication and 20 posters were presented. The program and most of the presentations can be found in www.or-nano.org.

I Biology

The session Biology started with the plenary lecture given by Barbara Gouget (CEA,[2] Saclay). She presented a summary of the research works performed in the world on the evaluation of the possible toxicity of gold nanoparticles. She drew the attention on the fact that some studies demonstrated that gold nanoparticles can be toxic to living organisms to some extent although gold is usually considered as biocompatible and non cytotoxic. The conclusion of her lecture is that more systematic studies are needed, the international community of scientists being divided and results of the investigation being contradictory. In her communication, Sophie Renault (University of Bordeaux[3]) showed that gold nanoparticles can alter the development of fresh water microalguas and micro bivalve molluscs. On the other hand, Christian Villiers (ISERM,[4] Grenoble) showed that gold nanoparticles can alter the metabolic activity of dendritic cells and as a consequence the immune reaction of living organisms.

If it is important to be careful with the problem of dissemination of nanoparticles in the environment, on the other hand, there are promising studies on the use of gold nanoparticles for biomedical applications. Christophe Alric (University Lyon I[5]) reported successful *in vivo* tests of gold nanoparticles properly functionalised by gadolinium complexes as contrast agent for X-ray imaging and magnetic resonance imaging, which are the techniques most used for medical diagnosis. Gold nanoparticles could also be used as therapy agent because of their radio sensitizing effect. The Hainfeld's team (USA) took advantage of this effect to destroy tumours induced in mouse bodies. To understand the radio sensitizer mechanism and characterise the effect, experiments are in progress in the group of Cécile Sicard at the University Paris XI, Orsay.[6] Her student, Emilie Brun, presented preliminary results. Another application was presented by Noël Bocar Diop (University Lyon I[5]), not with gold nanoparticles, but with silver nanoparticles embedded in a silica layer for possible applications as anti-bacterial agents in medical fabrics.

II Physical properties and characterisation

The session Physics included two plenary lectures and six short communications. The first plenary lecture presented by Sebastian Volz of Ecole Centrale of Paris,[7] dealt with thermic at the nanometric scale. Two aspects were developed: heat exchange between a nanoparticle and a matrix by ballistic conduction and near field thermal transfer between a nanoparticle and a surface or between two nanoparticles. The second plenary lecture presented by Alain Dereux of the University of Burgundy[8] was devoted to the state of the art of a new emerging field, the plasmonic. This field deals with the control and the handling of surface plasmon of gold thin films (thickness 20-30 nm), involving the collective oscillation of conduction electrons in gold under an electromagnetic field in the visible range, and the propagation of the fluctuation of the local charge. Plasmonic will probably play an important role in opto-electronic in the near future.

The short communications dealt with various topics. Grégory Barbillon (University Lyon 1[5]) and Martinus Werts (University of Rennes[9]) presented their studies on gold

nanostructures in interaction with molecular compounds. G. Barbillon presented gold nanoparticle arrays designed for the detection of bio-molecules as a possible future development of more reliable bio-sensors. The detection is based on the principle of multi-labelling by absorption spectroscopy for the detection of shifts in the gold plasmon band and by SNOM for the detection of luminescence. M. Werts also studies gold nanoparticles functionalised by fluorophores and the influence of the fluorophore-nanoparticle distance on the intensity of fluorescence, in playing with the length of the spacer molecule.

A different topic was proposed by Samir Benlekbir of INSA, Lyon[10] with the development of a method of tri-dimensional analysis of images of composites consisting of gold nanoparticles located in silica nanobeads by transmission electron microscopy. This method permits the determination of the 3-D localisation of the metal particles on the surface or in the volume of the silica beads. Using the same technique of imaging, Salem Marhaba of the University Lyon 1,[11] demonstrated that it is possible to correlate the morphology of gold nanoparticles observed by TEM with their optical spectrum of absorption. The extreme sensitivity of these experiments shows that it is possible to study a single particle. Finally, Chawki Awada, University Lyon 1, presented the results of his studies on the non linear optical response of a network of nanometric gold arrays, which show that the origin for the non linear response of these systems is due to surface defects of nanostructures and not to defects in their volume.

III Chemistry and catalysis

The session chemistry started with the plenary lecture of Arnaud Etcheberry (Lavoisier Institute, Versailles[12]), which dealt with the use of gold surfaces, and nanoparticles immobilised on functionalised surfaces for electrocatalysis, especially for reduction of oxygen in fuel cells. Four oral communications were then given in the fields of electrocatalysis and catalysis.

Hynd Remita (University Paris XI, Orsay[6]) showed that AuFe nanoparticles synthesised by radiolysis exhibit a high electro-activity for the reduction of H^+ and of O_2. Ngoc Dung Tran (IRCELYON[13]) reported the use of gold nanoparticles supported on ceria for the decomposition of organic molecules in water by air under pressure for water treatment. The catalysts containing fully metallic gold nanoparticles are the most efficient for the decomposition of succinic acid and acetic acid in CO_2 and H_2O. Violaine Mendez (IRCELYON) presented the results of a new « one-pot » method of synthesis of gold nanoparticles functionalised by citrate for the preparation of gold supported on TiO_2 for the reaction of epoxidation of substituted alkenes in weakly polar solvent. Finally, Elodie Quinet (IRCELYON) presented the results of a kinetics study showing the influence of hydrogen on the kinetics of the reaction of CO oxidation. She proposed a mechanism of reaction involving OOH-type intermediates (arising from a reaction between adsorbed hydrogen and molecular oxygen), which would preferentially react with CO at low temperature.

IV Synthesis of gold nanoparticles

These three sessions involved the critical step of synthesis of gold nanoparticles adapted to the applications or to the properties studied. A few presentations focused more exclusively on synthesis. This was the case of Yaasin Ramjauny (Ecole Polytechnique[14]) who presented a study on ionic irradiation of gold nanoparticles embedded in a silica matrix. The irradiation leads to a decrease in the particle size and an increase in the particle concentration. The analysis of the intermediate steps allowed to characterise the process of nucleation and growth of gold particles during irradiation. Fabien Miomandre (ENS Cachan[15]) presented an original synthesis of hybrid nanoparticles of «core-shell» type with a core of metal (Au or Ag) encapsulated in a shell of silica for applications in dielectrophoretic display. An original method of synthesis of gold nanoparticles with triangular morphology was proposed by the group of M. Tréguer-Delapierre (ICMCB, Bordeaux[16]). Such type of particles absorb in the near-infrared region. Jeremiasz Jeszka (Polish Academy of Sciences, collaboration with the LLC, Toulouse[17]) presented a method of functionalisation of gold nanoparticles by molecules containing photoactive pyrene functions. The synthesis of gold nanoparticles by chemical reduction in the organic hexadecylamine is the key-step to make the functionalisation easier. Finally, Sabine Szunerits (LEPMI, St. Martin d'Hères[18]) presented several approaches (chemical, electrochemical and CVD) for the synthesis of gold nanoparticles on glass surfaces as sensors for further detection of heavy metals by surface plasmon resonance.

References

1 Centre National pour la Recherche Scientifique
2 Laboratoire Pierre Süe, Commisariat à l'Energie Atomique, Saclay
3 Géochimie et Écotoxicologie des Métaux dans les systèmes Aquatiques, Laboratoire d'Imagerie Moléculaire et de Nanobiotechnologie, University Bordeaux 1
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5 Laboratoire Physico-Chimie des Matériaux Luminescents, University Claude Bernard Lyon 1
6 Laboratoire de Chimie Physique, University Paris XI, Orsay
7 Laboratoire Energétique Moléculaire et Macroscopique, Combustion, Ecole Centrale Paris
8 Institut Carnot de Bourgogne, University of Burgundy, Dijon
9 Chimie et Photonique Moléculaires, University Rennes 1
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13 Institut de Recherches sur la Catalyse et l'Environnement de Lyon, CNRS
14 Laboratoire des Solides Irradiés, Ecole Polytechnique, Palaiseau
15 Laboratoire de Photophysique et Photochimie Supramoléculaires et Macromoléculaires, Ecole Normale Supérieure de Cachan
16 Institut de Chimie de la Matière Condensée de Bordeaux, CNRS, Bordeaux
17 Centre for Molecular and Macromolecular Studies, Poland and Laboratoire de Chimie de Coordination, CNRS, Toulouse
18 Laboratoire d'Electrochimie et de Physicochimie des Matériaux et des Interfaces, St. Martin d'Hères